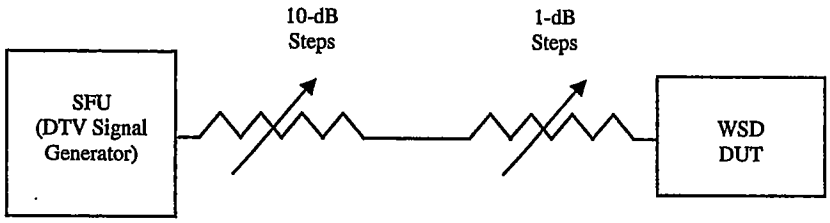

Figure A-1. "Clean" DTV Signal Measurement Equipment Configuration.

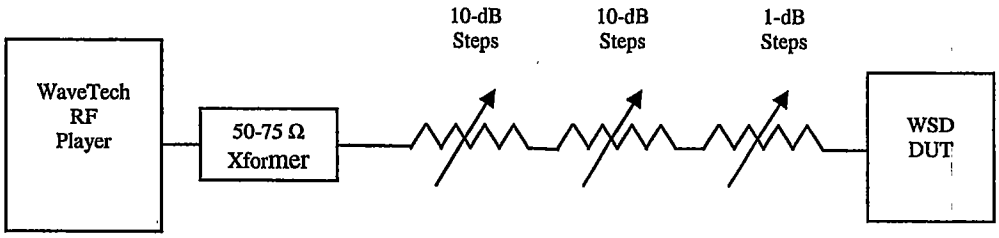

Figure A-2. "Recorded" DTV Signal Measurement Equipment Configuration.

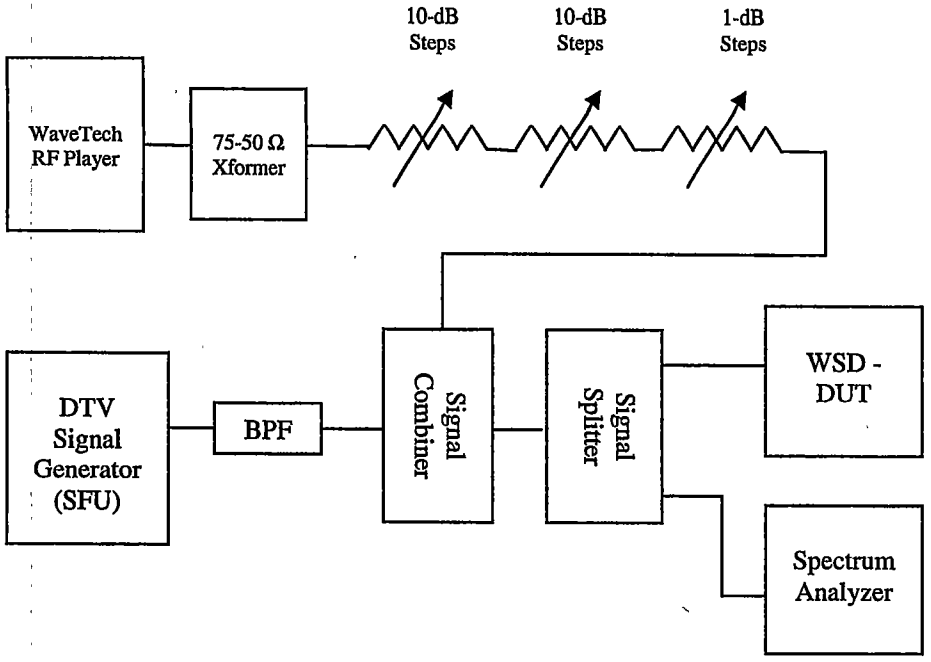

Figure A-3. Adjacent Channel Interference Measurement Equipment Configuration.

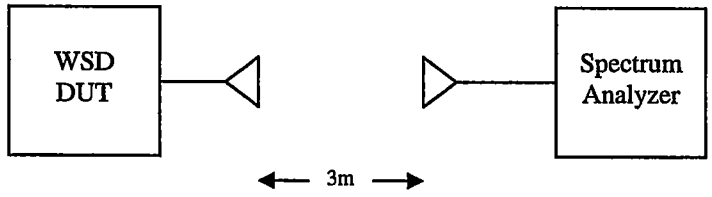

Figure A-4. Spurious Emission and EIRP Measurement Equipment Configuration.

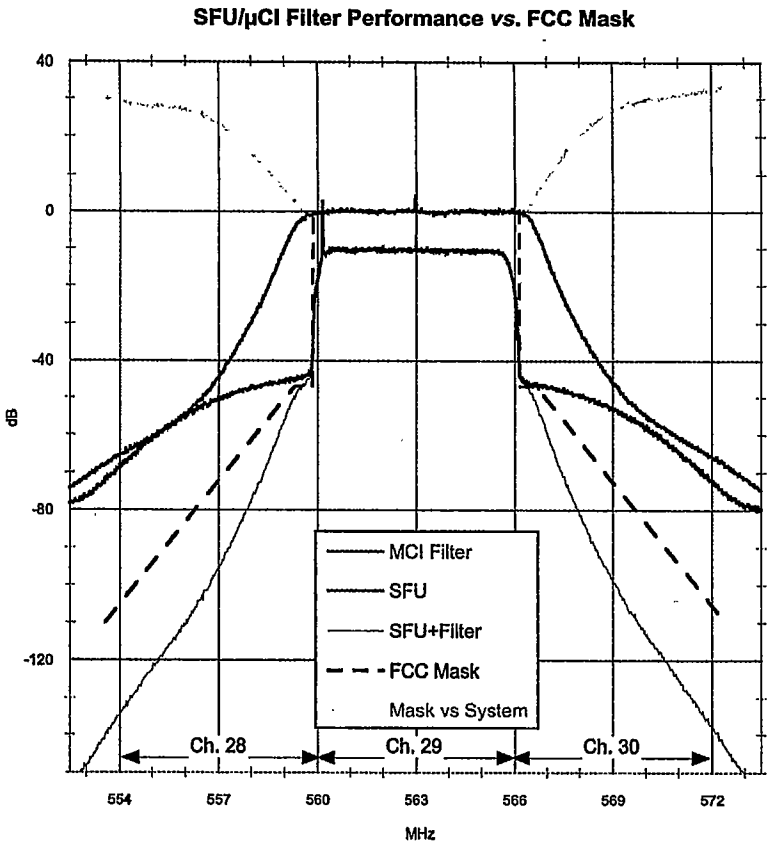

Figure A-5. Filtered SFU Signal Compared to DTV Emissions Mask.

Appendix B
RF Capture Information

This appendix provides detailed information regarding the twelve DTV signal RF captures used in the sensitivity threshold measurements. Section B.1 provides general information for each of the capture signals. Section B.2 provides spectrum traces of each of the signals. Section B.3 provides temporal plots of each signal over its 24.5-second playback period.

B.1 Summary of RF Capture Information

Table B-1 provides general information regarding the twelve captured waveforms utilized in this effort.

Table B-1. RF Capture Information.[1]

Waveform	Type of Capture	Lower Adjacent Channel	Upper Adjacent Channel	Close-in Echo(es)	Multiple Echo(es)	Deep Notch(es)	Wide Notches	Flat Fading	Band Edge Distortion	Pilot Notch
WAS_06_34	Outdoor - 30'	None	ATSC	-	-	-	-	-	-	-
WAS_03_27	Outdoor - 30'	NTSC	None	-	Y	Y	-	-	-	Y
WAS_311-35	Outdoor - 30'	ATSC	ATSC	-	Y	-	-	Y	-	-
WAS-311-36	Outdoor - 30'	ATSC	None	-	Y	Y	Y	-	-	-
WAS_311_48	Outdoor - 30'	None	None	-	Y	Y	Y	-	-	-
WAS_32_48	In-home	None	None	-	Y	Y	Y	-	-	-
WAS_47_48	In-home	None	None	-	Y	-	-	Y	-	-
WAS_49_34	In-home	None	ATSC	-	Y	Y	-	Y	Y	-
WAS_49_39	In-home	None	None	-	Y	Y	-	-	-	-
WAS_51_35	Outdoor - 30'	ATSC	ATSC	-	-	-	-	Y	-	-
WAS_68_36	Outdoor - 30'	ATSC	None	-	-	-	-	Y	-	-
WAS_86_48	Outdoor - 30'	None	None	-	-	-	-	-	-	-

[1] Advanced Television Systems Committee, *ATSC Recommended Practice: Receiver Performance Guidelines (with Corrigendum No. 1)*, Doc A/74, Annex A, July, 2007.

B.2 Frequency Domain Representations.

The following spectrum analyzer traces demonstrate the frequency domain characteristics of each of the RF capture waveforms utilized in this effort.

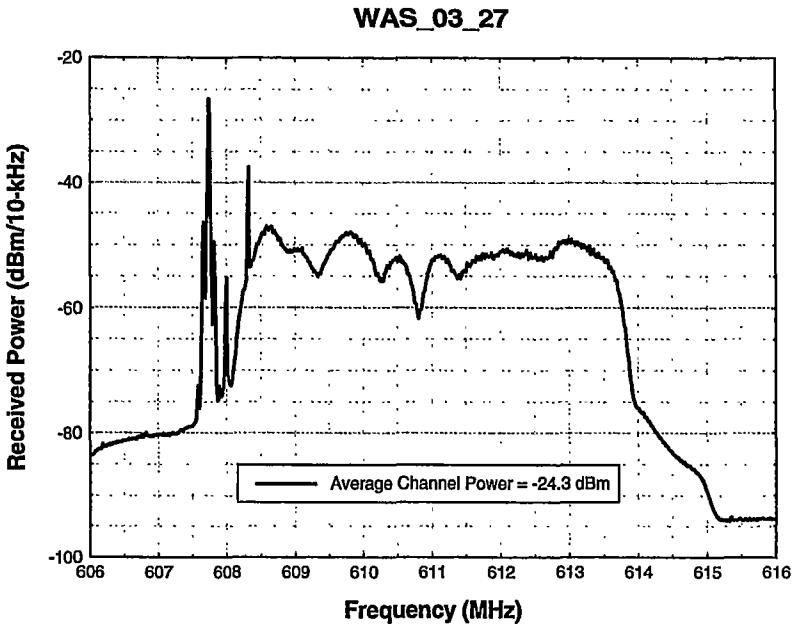

Figure B-1. WAS_03_27 RF Capture

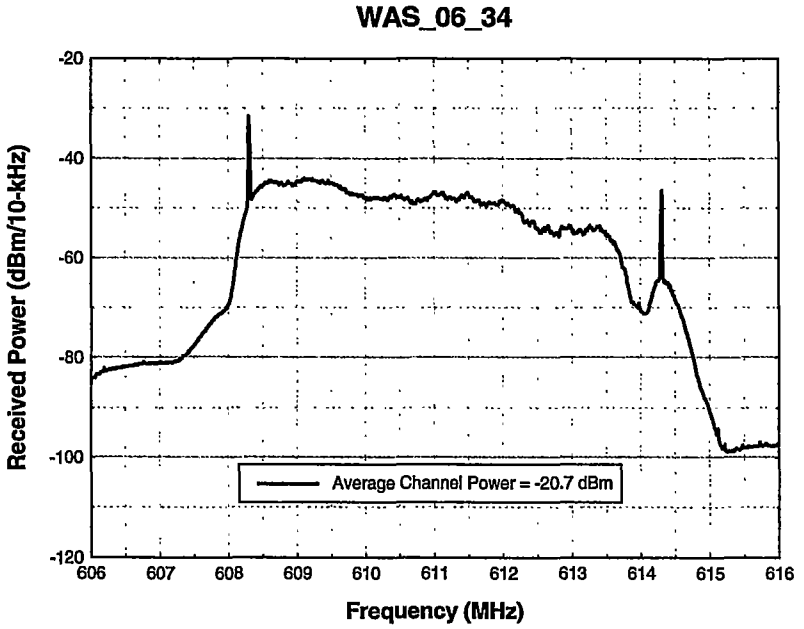

Figure B-2. WAS_06_34 RF Capture

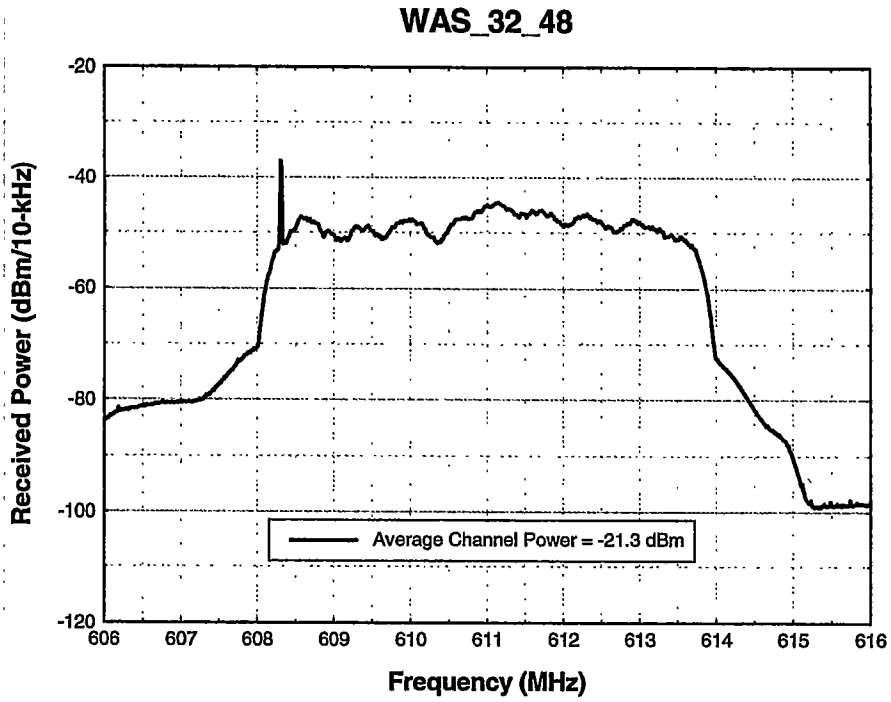

Figure B-3. WAS_32_48 RF Capture

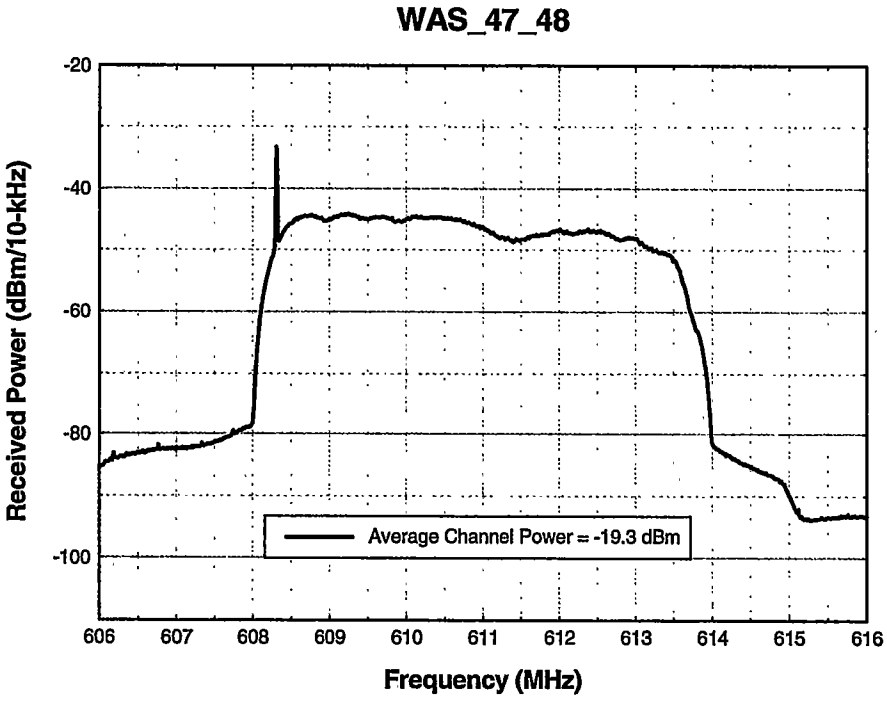

Figure B-4. WAS_47_48 RF Capture

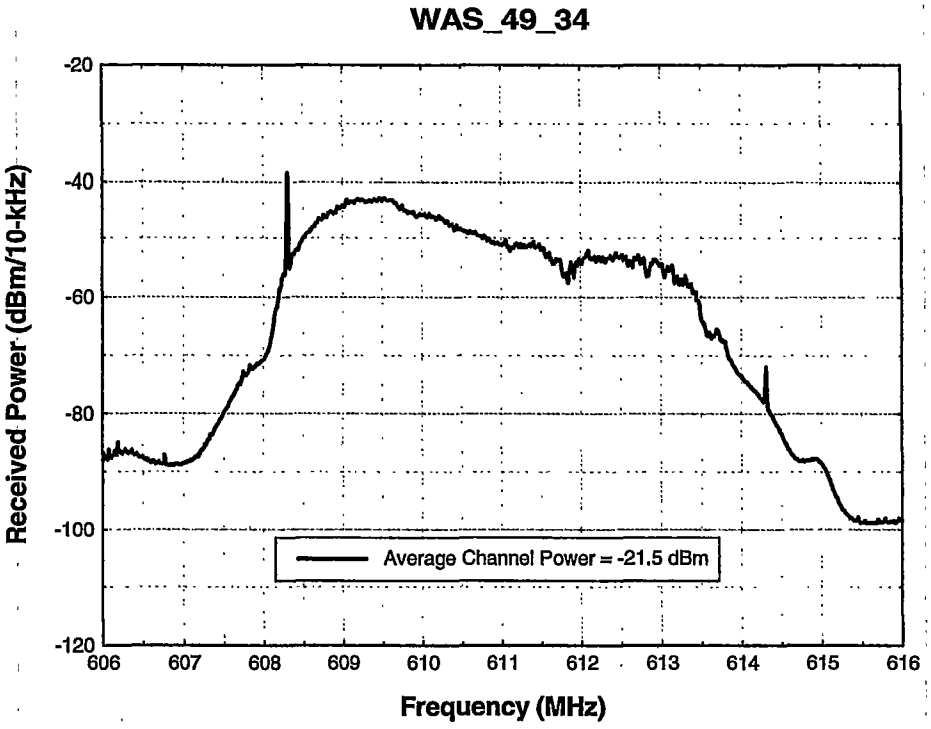

Figure B-5. WAS_49_34 RF Capture

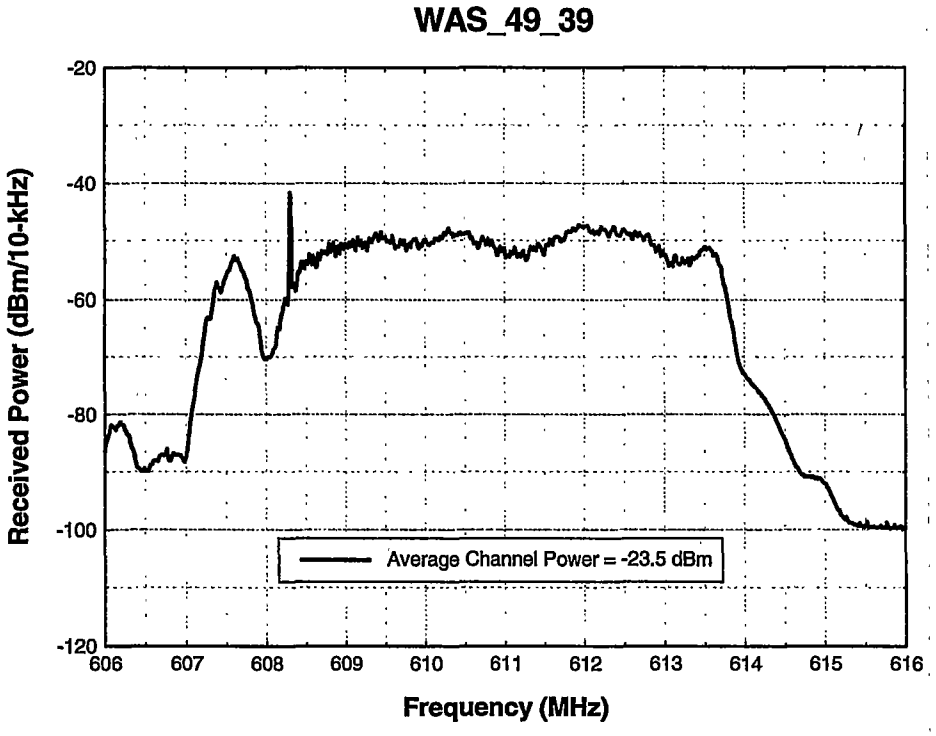

Figure B-6. WAS_49_39 RF Capture

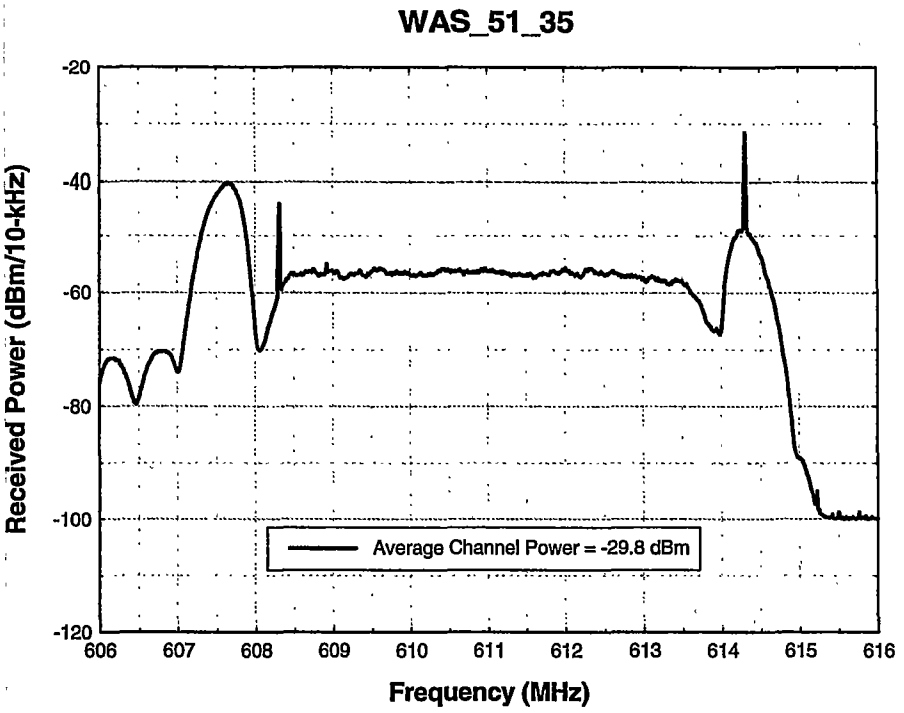

Figure B-7. WAS_51_35 RF Capture

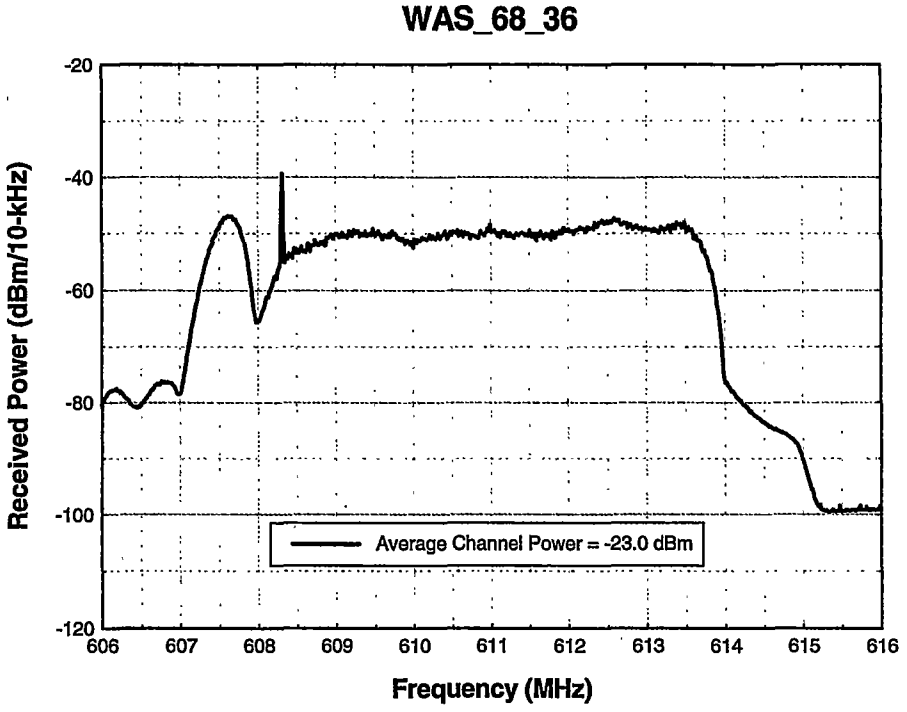

Figure B-8. WAS_68_36 RF Capture

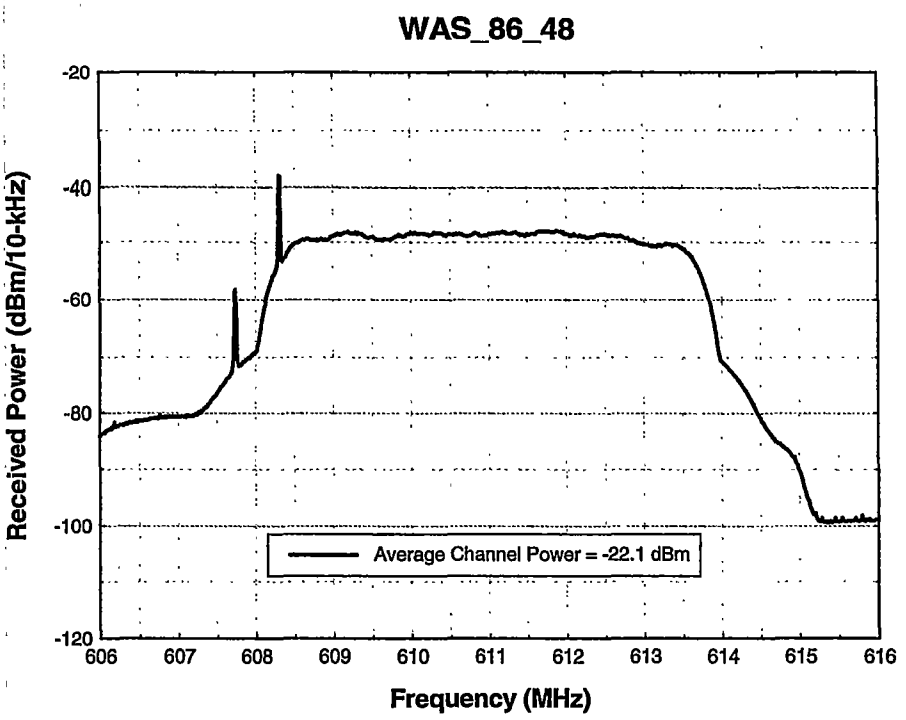

Figure B-9. WAS_86_48

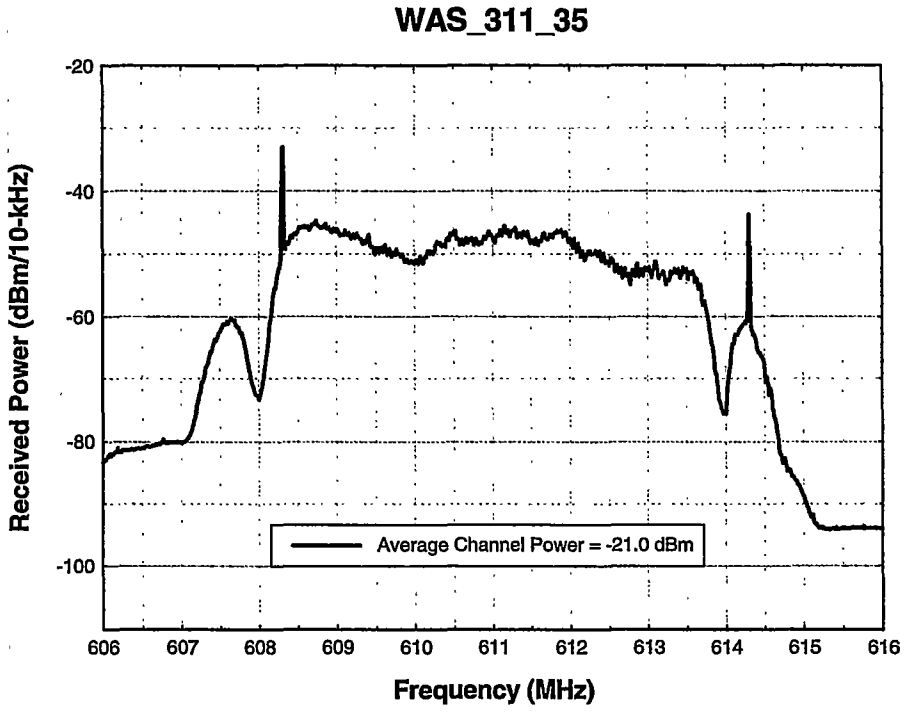

Figure B-10. WAS_31_35

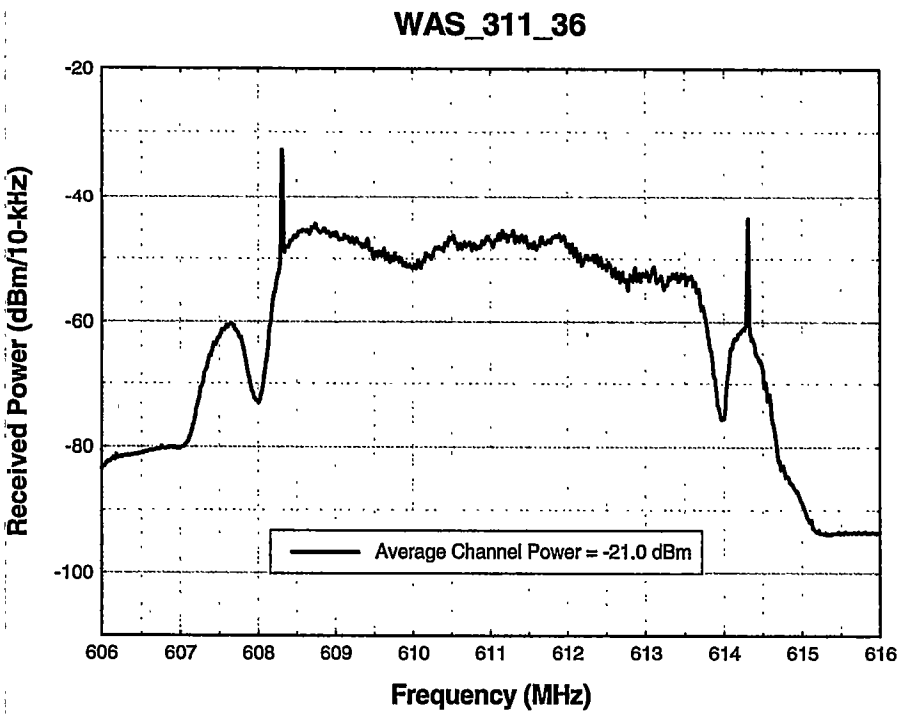

Figure B-11. WAS_311_36

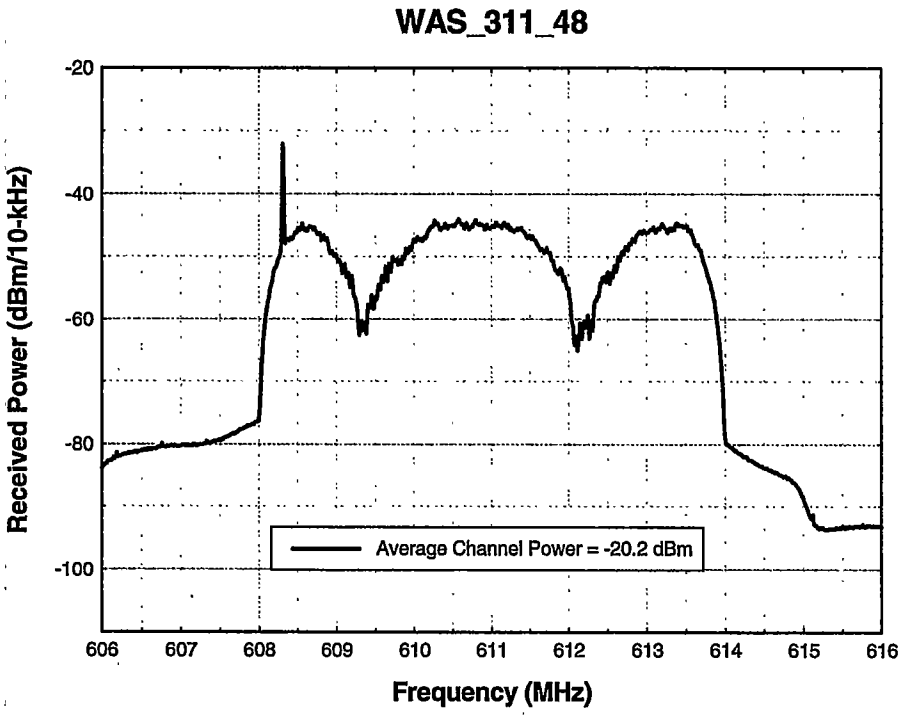

Figure B-12. WAS_311_48 RF Capture

B.3. Temporal Representations.

The following temporal plots, acquired using a vector signal analyzer (VSA), illustrate the time-domain characteristics associated with each of the RF capture waveforms utilized in this measurement effort.

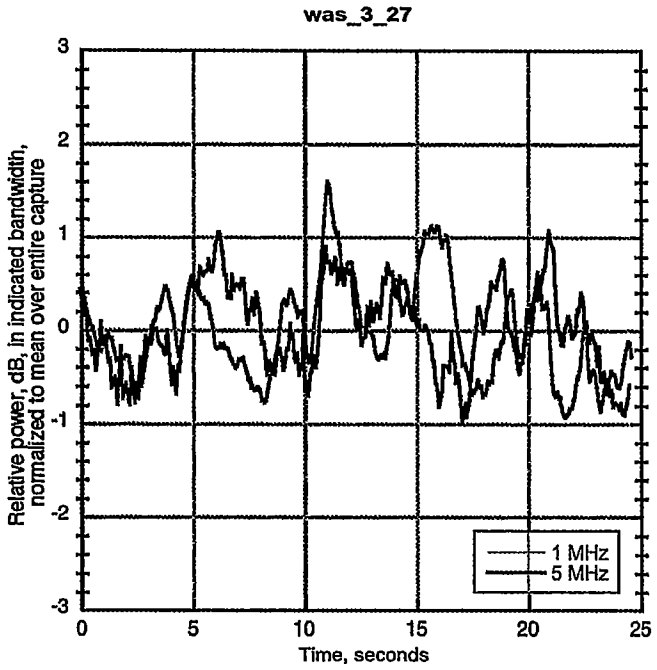

Figure B-13. WAS_3_27 Temporal Representation

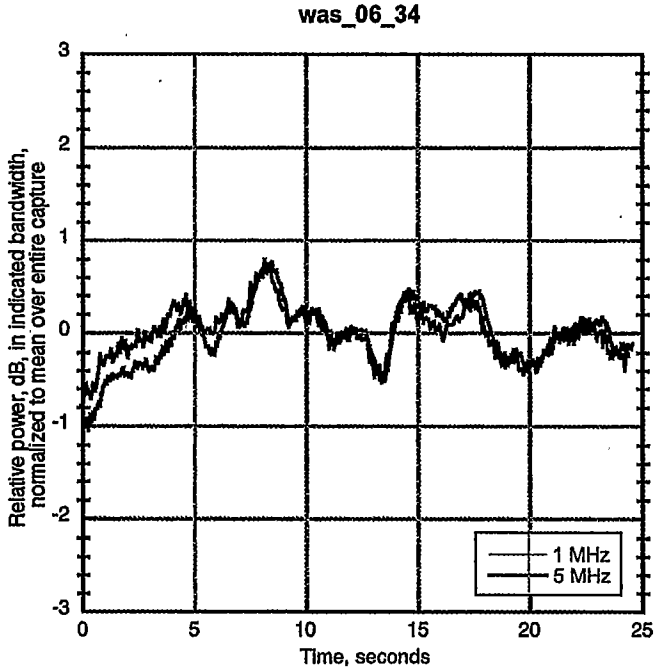

Figure B-14. WAS_06_34 Temporal Representation

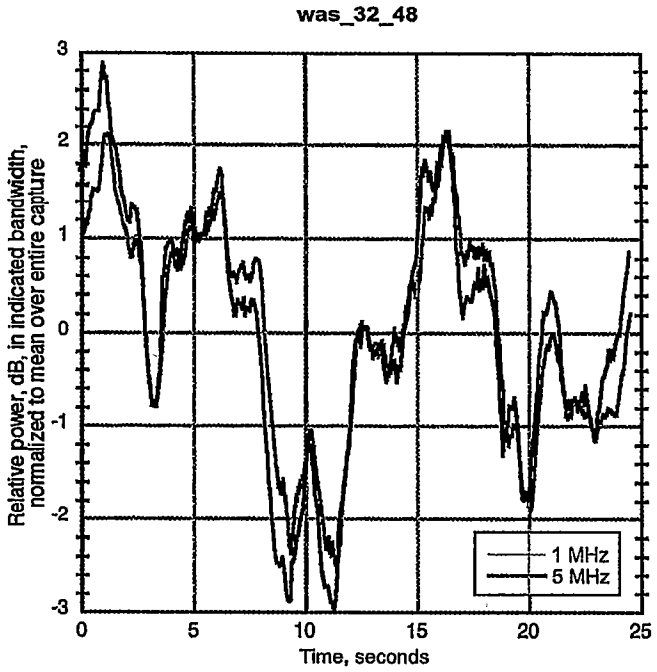

Figure B-15. WAS_32_48 Temporal Representation

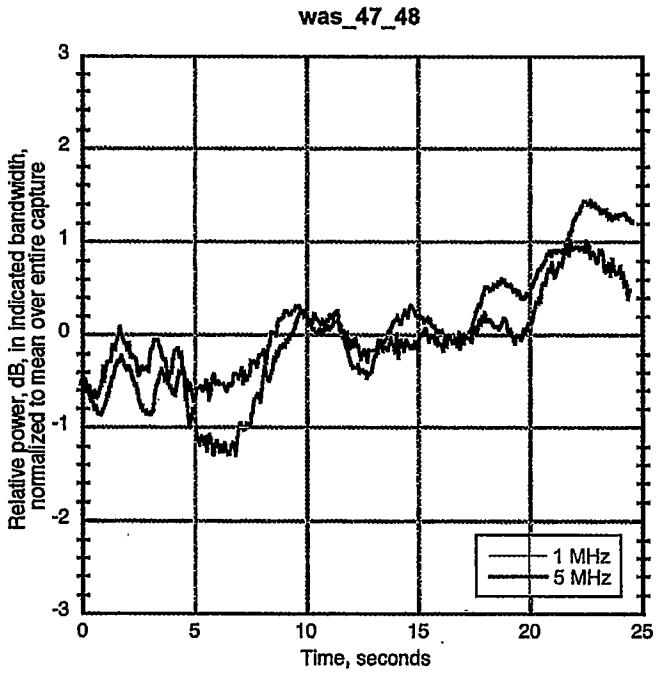

Figure 16. WAS_32_48 Temporal Representation

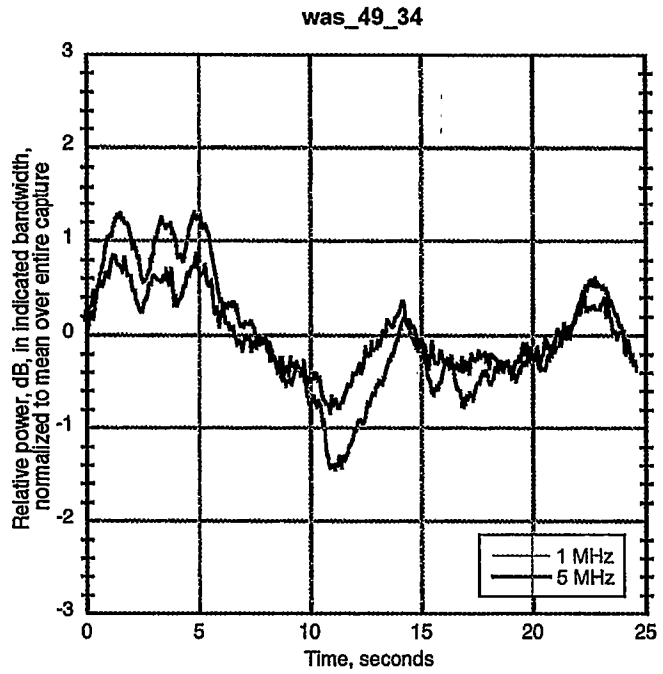

Figure B-17. WAS_49_34 Temporal Representation

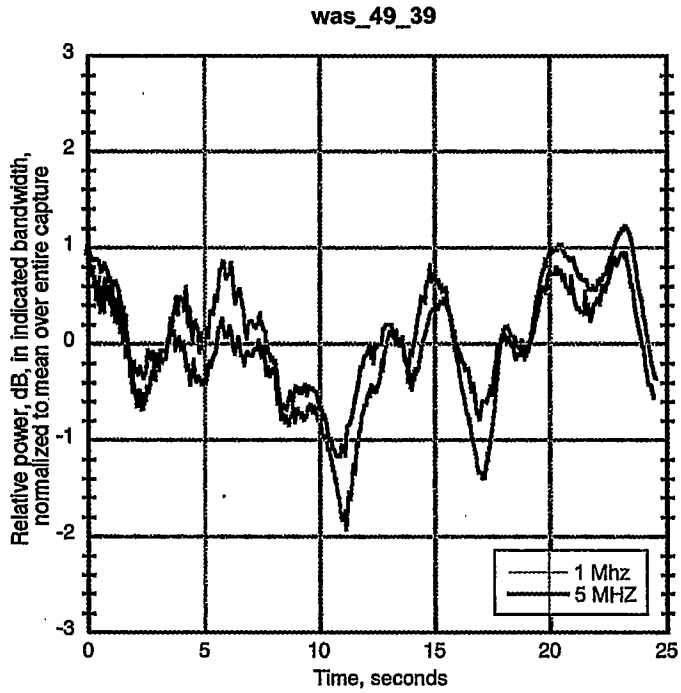

Figure B-18. WAS_49_39 Temporal Representation

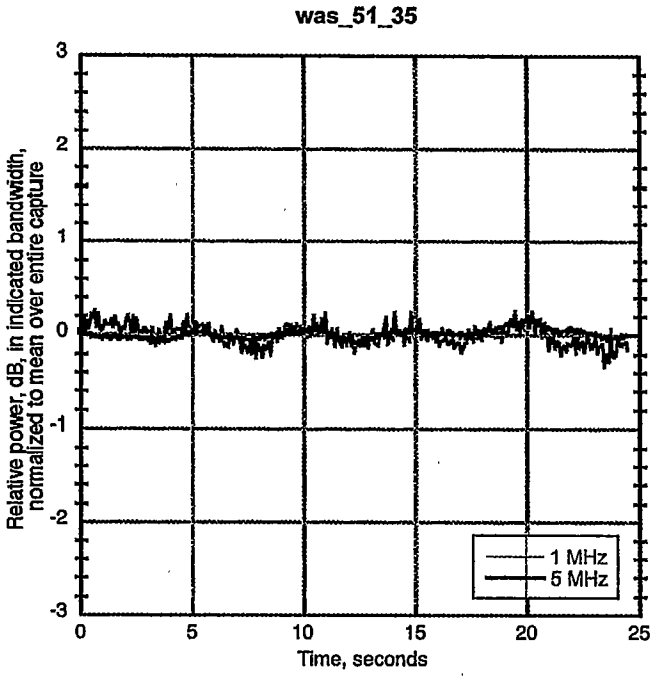

Figure B-19. WAS_51_35 Temporal Representation

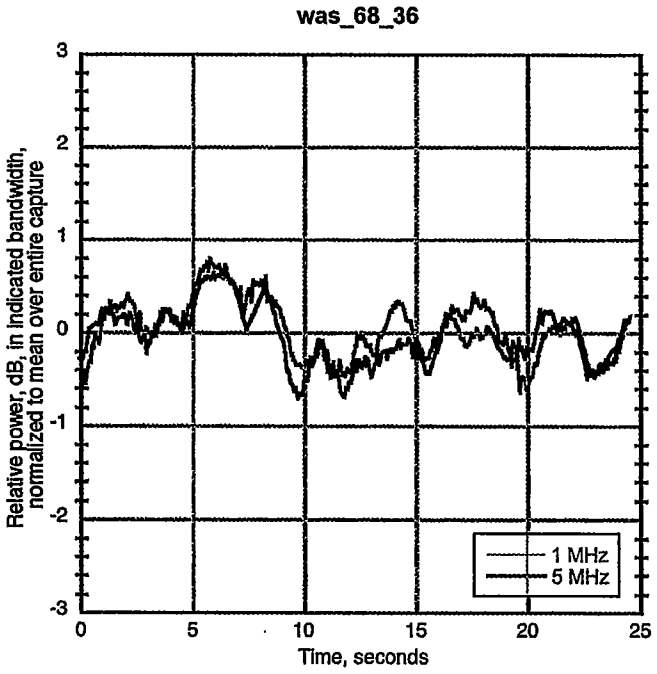

Figure B-20. WAS_68_36 Temporal Representation

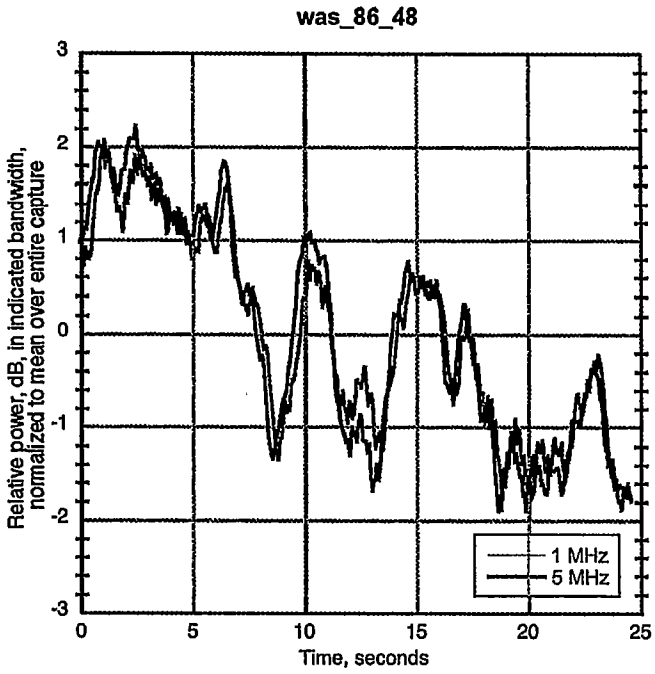

Figure B-21. WAS_86_48 Temporal Representation

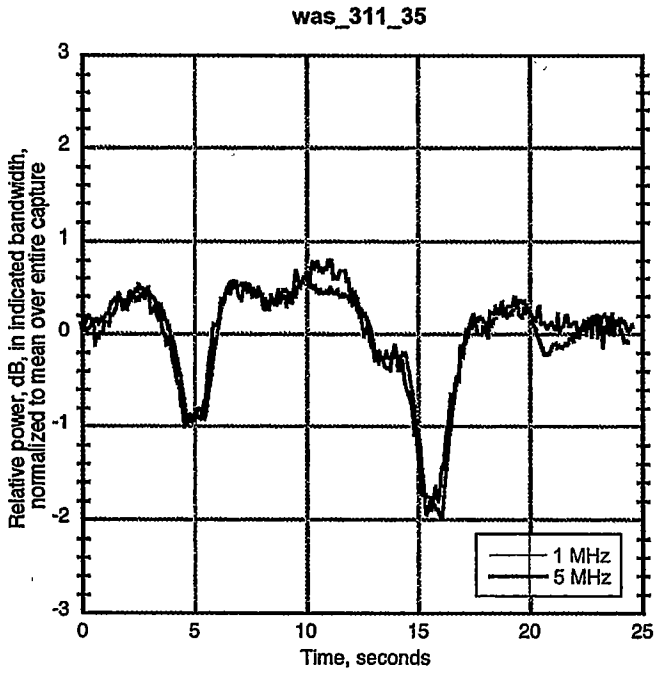

Figure B-22. WAS_311_35 Temporal Representation

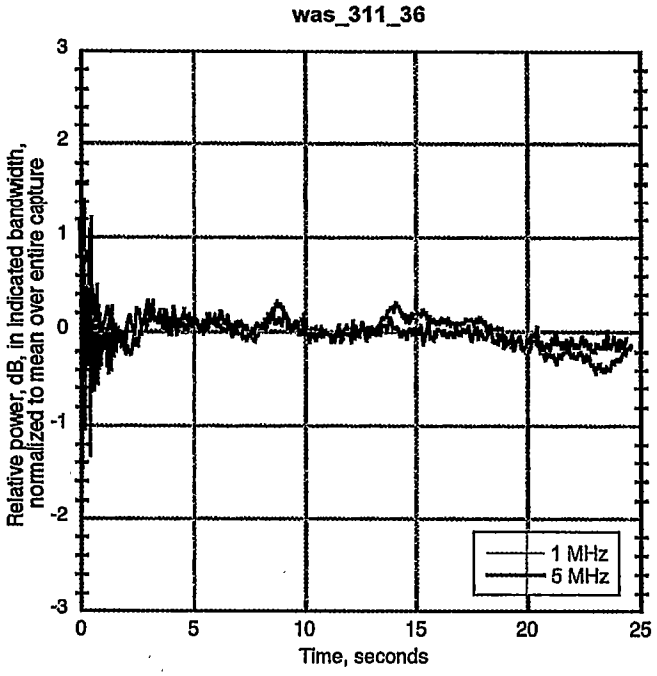

Figure B-23. WAS_311_36 Temporal Representation

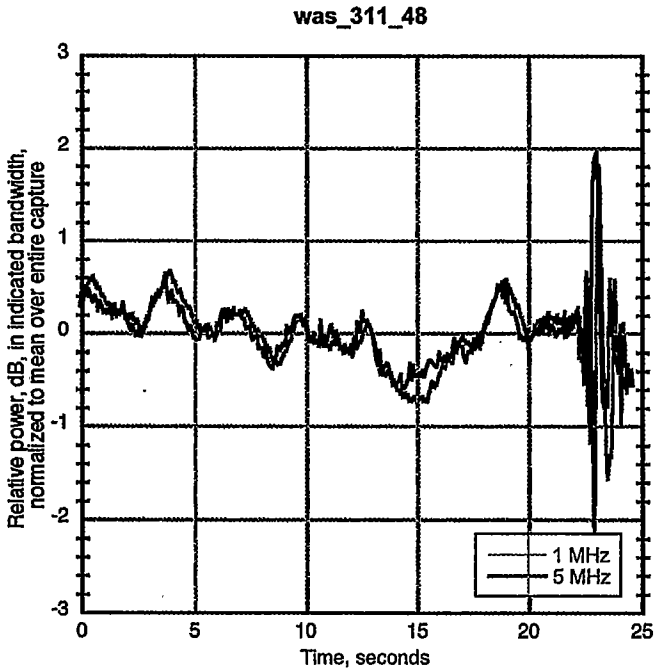

Figure B-24. WAS_311_48 Temporal Representation

Appendix C
Measurements of Received Carrier Level at Field Test Sites

C.1 Measurement Objective

It is of interest to determine whether White Space Devices (WSDs) detect all television signals that can be received by typical consumer receiving installations. At most WSD field test locations,[1] measurements using an elevated TV antenna were made to determine the receive carrier level (RCL) that might be expected at a television receiver input from a typical consumer antenna system. Additionally, each TV channel was observed using a consumer receiver to determine whether a "viewable" picture was present. A spectrum analyzer was used to determine whether ATSC, NTSC, or other signals were present, even if there was no usable picture, and to measure their RCL. These measurements were made in the vicinity (typically within 100 feet) of the field trial locations used for testing the white space devices.

C.2 Measurement Equipment

An FCC-truck with an integrated 30-foot pneumatic mast was configured with a consumer TV antenna, NTSC and DTV receivers, a spectrum analyzer, and ancillary equipment. The antenna used for the measurements was a Radio Shack Model VU-90XR with an estimated average gain of 7.0 dBd over TV Channels 21-51. The measured loss of the coaxial downlead cable was 3.9–4.6 dB over the same range of channels. A 75-to-50 ohm transformer, having a loss of about 1 dB was used to match the antenna to the downlead cable, making the effective average loss of the downlead 5.3 dB. For comparison, the FCC's DTV planning factor values are 10 dBd antenna gain and 4 dB line loss, so the performance of the receiving system falls short of the planning factor values by about 4.3 dB.

The spectrum analyzer used for the measurements was an Agilent Type E7405. A JVC Model LT-26X776 TV receiver was used for NTSC reception and also as a display for DTV reception. A Magnavox Model TB100MW9 set-top box was used as the tuner for DTV reception. For NTSC signals, the peak-of-sync level of the visual carrier was measured; for DTV signals, the integrated power over 6 MHz was generally measured.[2]

C. 3 Measurement Protocol

With the spectrum analyzer in "peak hold" mode, the RF spectrum from 50 to 1000 MHz was observed, while the elevated TV antenna was rotated through 360 degrees to determine the maximum signal level. The maximum observed signal level was used to establish at each site

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1 No measurements of RCL from an outdoor antenna were made using the field truck at the FCC Headquarters building. However, measurements were made at that location indoors, using a biconical antenna.

2 At the first field test site (Patapsco Park), measurements were made of the level of the DTV pilot carrier, instead of band-power measurements. In the data reported, a factor of 11.8 dB has been added to the pilot measurement result to estimate the total DTV power. See L. Gumm, "Measurement of 8VSB DTV Transmitter Emissions," IEEE Trans. On Broadcasting, July 1999.

appropriate reference level, input attenuation, and internal pre-amplifier settings for the spectrum analyzer to ensure that overload did not occur.

Each 6 MHz TV channel was observed on the spectrum analyzer as the receiving antenna was rotated to determine whether ATSC, NTSC, or other signals were present, and to determine the azimuth of maximum signal level. In some cases, more than one type of signal was present, with the maximum levels occurring at different azimuths. The frequency of the ATSC pilot, NTSC visual carrier, or other signal was measured. The NTSC peak of sync visual power or ATSC average power in 6 MHz was then measured as an average over 100 sweeps.

The antenna downlead was then connected to the appropriate receiver to determine whether a usable picture could be demodulated. If the RCL seemed adequate, yet no picture was produced, the rotor was adjusted while monitoring to determine whether an optimum azimuth for reception could be obtained. The above procedure was repeated for each channel with an observed NTSC or ATSC signal. Depending upon the number of signals present, these measurements and observations took 1–2 hours per site.

At some locations, measurements inside the truck were followed by comparative RCL measurements using a WSD antenna at or near ground level (~ 2m AGL). Several of the strongest ATSC or NTSC signals were selected in advance, and were observed on the spectrum analyzer connected to WSD antenna. The RCL was measured as before. Generally, the WSD antenna supplied by Adaptrum was used for these RCL measurements. The Adaptrum antenna is a vertically-polarized planar bi-conical – essentially a dipole whose elements have a triangular shape and fed at the apexes. The antenna was set atop at tripod at a center height above ground of about 6.2 feet.

C.4 Measurement Locations

Measurements were performed at the following locations. Precise geographic coordinates are reported in Section 5 of this report.

Table C-1. Measurement Locations

Location No.	Date	Location (all Maryland, except as noted)
1	July 16, 2008	Patapsco Valley State Park
2	July 17, 2008	Thomas A. Dixon, Jr. Aircraft Observation Area
3	July 22, 2008	Private residence, Ellicott City
4	July 24, 2008	Private residence, College Park
5	July 29, 2008	FCC Headquarters, Washington, DC
6	July 31, 2008	Private residence, Galesville
7	August 4, 2008	Doub's Meadow Park, Myersville
8	August 5, 2008	Wolfsville Road/Middle Point Road, Myersville
9	August 6, 2008	Wolfsville Road/Meeting House Road, Myersville

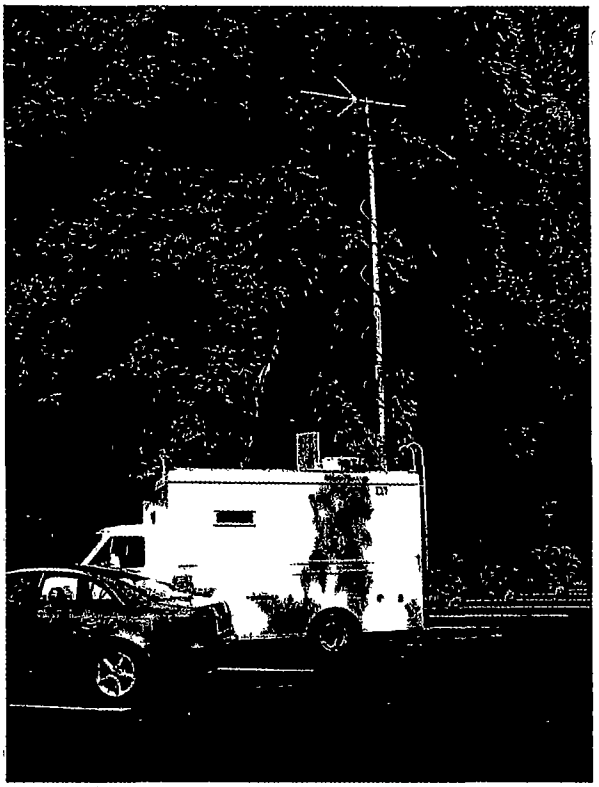

Figure C-1. Site 1, Patapsco Valley State Park

C.5 Comparisons of RCL Between Consumer Outdoor and WSD antennas

At six of the measurement sites, the spectrum analyzer was connected to a WSD antenna and the RCL of a few TV stations was measured for comparison with the elevated consumer antenna system. As previously noted, the consumer antenna was elevated and generally clear of obstacles, horizontally polarized, and had relatively high gain. The WSD antennas were fairly near the ground and sometimes had nearby obstacles, vertically polarized, had low gain, and were sometimes indoors. At Site #1, the Motorola helical antenna was used, while the Adaptrum antenna was used at all other sites.

At the most terrain-obstructed outdoor sites, 1 and 9, it appears that the fields were so disturbed that there was little difference between the two antennas. At the two residential sites, 3 and 6, fairly large differences in RCL are seen, presumably because all of the factors identified above favored the outdoor antenna. The data collected from these measurements is presented in Table C-3.

C.6 Interpretation of Measurement Data

Tables C-4 through C-13 of this appendix provide the results of the field RCL measurements. The following guidance is provided to assist in the interpretation of the test data.

"Channel" – The 6 MHz TV channel number as defined in Section 73.603 of FCC Rules.

"Signal Type (N or D)" – Whether the predominant signal observed was NTSC or DTV (ATSC). In some cases, both NTSC and DTV signals were successfully demodulated (with the antenna directed toward different directions).

"Frequency (MHz)" – The measured frequency of the visual carrier (for NTSC) or the pilot (for DTV). Note that the resolution of the frequency measurement may vary.

"Measured Power (dBm)" – Received carrier level, averaged over 100 sweeps, of the visual carrier (for NTSC) or integrated over the 6 MHz channel (for DTV). As noted previously, at the Patapsco Site, the reported DTV level was determined by measurement of the DTV pilot plus 11.8 dB. In some cases, the measurement was limited by the noise floor of the spectrum analyzer, in which case the actual level is "≤" (less than or equal to) the value reported.

"Viewable (Picture/TASO)" – Whether a proper picture was present (Yes or No) for DTV stations. At locations where the DTV signal was not consistently demodulated, the word "occasional" is used. The quality of the picture (rated 1 to 6) is reported for NTSC stations. The TASO rating scale is defined as follows:

Table C-2. TASO Rating Scale

TASO Grade	Faults of Reception	Description
1	No perceptible faults	As good as you could desire
2	Just perceptible faults	High quality viewing
3	Perceptible, but not objectionable faults	Acceptable quality
4	Somewhat objectionable faults	Poor quality
5	Definitely objectionable faults	Very poor and inferior
6	Not usable	Not watchable
N	No video signal detected	

A blank line (no entries, apart from channel number) indicates that no significant signals were observed.

"Reported PSIP" – the channel number displayed by the DTV receiver. This value is not reported in all cases.

Table C-3. Outdoor Consumer *vs.* WSD Antenna RCLs

Location	Channel	30-foot RCL (dBm)	WSD RCL (dBm)	Difference (dB)
1	22 (N)	-74.0	-71.3	+2.7
	24 (N)	-55.0	-52.6	+2.4
	38 (D)	-72.5	-81.4	-8.9
	40 (D)	-77.0	-78.8	-1.8
	41 (D)	-69.6	-74.4	-4.8
	45 (N)	-77.3	-77.9	-0.6
	46 (D)	-74.0	-84.5	10.5
3	22 (N)	-29.8	-63.5	-33.7
	32 (N)	-40.1	-74.1	-34.0
	39 (D)	-27.4	-50.6	-23.2
	40 (D)	-30.9	-61.1	-30.2
	45 (N)	-28.8	-58.0	-29.2
	46 (D)	-30.0	-57.5	-27.5
6	24 (N)	-59.0	-80.8	-21.8
	32 (N)	-67.5	-93.3	-25.8
	34 (D)	-63.5	-85.5	-22.0
	42 (D)	-44.8	-75.8	-31.0
	46 (D)	-54.3	-80.4	-26.1
10	22 (N)	-69.0	-86.6	-17.6
	34 (D)	-72.0	-90.0	-18.0
	35 (D)	-73.1	-90.1	-17.0
	36 (D)	-74.3	-90.0	-15.7
	47 (D)	-78.4	-91.1	-12.7
7	25 (N)	-77.7	-87.8	-10.1
	30 (D)	-72.7	-89.9	-17.2
	31 (N)	-75.6	-83.9	-8.3
9	22 (N)	-92.9	-96.8	-3.9
	25 (N)	-94.5	-100.0	-5.5
	31 (N)	-91.7	-97.3	-5.6
	42 (N)	-100.5	-100.4	+0.1

Table C-4. Measurement Results – Patapsco Site

Channel	Signal Type (N or D)	Frequency (MHz)	Measured Power (dBm)	Viewable (Picture/TASO)	Reported PSIP
21					
22	N	519.28	-74.0	4	
23					
24	N	531.26	-55.0	3	
25					
26	N	543.24	-96.6	6	
27					
28	D	554.3	-96.3	N	
29	D	560.3	-90.9	N	
30					
31					
32	N	579.26	-99.3	N	
33	D	584.3	-86.0	N	
34					
35	D	596.3	-85.5	N	
36	D	602.3	-85.0	N	
37					
38	D	614.3	-72.5	Y	
39					
40	D	626.3	-77.0	Y	54.1
41	D	632.3	-69.6	Y	
42	D	638.3	-87.0	N	
43	N	645.25	-97.9	N	
44					
45	N	657.25	-77.3	4	45.1
46	D	662.3	-74.0	Y	
47	N	669.2	-88.3	N	
48	D	674.3	-87.8	N	
49	N	681.2	-103.2	N	
50	N	687.25	-95.3	6	
51	N	693.2	-93.9	N	

Table C-5. Measurement Results – Thomas A. Dixon, Jr. Site

Channel	Signal Type (N or D)	Frequency (MHz)	Measured Power (dBm)	Viewable (Picture/TASO)	Reported PSIP
21	D	512.3	<71	N	
22	N	519.28	-39.4	2	
23	D	524.3	<67.3	N	
24	N	531.26	-28	1	
25	N	537.24	-88.6	N	
26	N	543.24	-79.5	N	
27	D	548.3	-65.4	Y	
28	N	555.24	-90	5	
29	D	560.3	-47.9	Y	
30	D	566.3	<69.8	N	
31					
32	N	579.26	-73.4	4	
33	D	584.3	-81.6	Y	
34	D	590.3	-59.1	Y	
35	D	596.3	-62.6	Y	
36	D	602.3	-62.2	Y	
37					
38	D	614.3	-16	Y	
39	D	620.3	-65.3	N	
40	D	626.3	-20.4	Y	
41	D	632.3	-44.7	Y	
42	D	638.3	-43.9	Y	
43	N	645.25	-72.7	6	
44					
45	N	657.25	-23	2	
46	D	662.3	-20.7	Y	
47	N	669.2	-78.7	N	
48	D	674.3	<-69.2	N	
49	N	681.2	-93.1	N	
50	N	687.25	-66.1	5	
51	N	693.2	-69.1	N	

Table C-6. Measurement Results – Ellicott City Site

Channel	Signal Type (N or D)	Frequency (MHz)	Measured Power (dBm)	Viewable (Picture/TASO)	Reported PSIP
21	N	513.25	-95.7	N	
22	N	519.28	-29.8	1	
23	N	525.2	-72	N	
24	N	531.26	-39.2	1	
25	N	537.24	-72.8	N	
26	N	543.24	-37.2	1	
27	D	548.3	-50.9	Y	26.1
28	D	554.3	-50.9	Y	62.1
29	D	560.3	-64.4	Y	67.1
30	D	566.3	-68.3	Y	30.1
31	N	573.25	-90.6	4	
32	N	579.26	-40.1	1	
33	D	584.3	-51.7	Y	32.1
34	D	590.3	-43	Y	9.1
35	D	596.3	-41.8	Y	20.1
36	D	602.3	-38.6	Y	5.1
37					
38	D	614.3	-27.4	Y	13.1
39	D	620.3	-44.2	Y	7.1
40	D	626.3	-30.9	Y	54.1
41	D	632.3	-42.7	Y	24.1
42	D	638.3	-51.1	Y	22.1
43	N	645.25	-79.2	5	
43	D	644.3	-66	Y	66.1
44					
45	N	657.25	-28.8	1	
46	D	662.3	-30	Y	45.1
47	N	669.24	-82	5	
48	D	674.3	-43.8	Y	4.1
49	N	681.26	-77.8	5	
50	N	687.25	-40.5	1	
51	D	692.3	-49.7	Y	50.1

Table C-7. Measurement Results – College Park

Channel	Signal Type (N or D)	Frequency (MHz)	Measured Power (dBm)	Viewable (Picture/TASO)	Reported PSIP
21					
22	N	519.28	-63.1	2	
23	N	525.24	-48.2	2	
24	N	531.26	-67.5	2	
25	N	537.25	-66.6	3	
26	N	543.24	-47.5	2	
27	D	548.325	-47.3	Y	26.1
28					
29	D	560.3035	-77	Y	67.1
30	D	566.3085	-78.1	Occasional	30.1
31					
32	N	579.26	-42.2	1	
33	D	584.3435	-46.7	Y	32.1
34	D	590.3112	-37.2	Y	9.1
35	D	596.3111	-49.7	Y	20.1
36	D	602.3112	-45.5	Y	5.1
37					
38	D	614.3102	-70.8	Y	13.1
39	D	620.3104	-45.7	Y	7.1
40	D	626.31	-68.7	Y	54.1
41					
42	D	638.3105	-74	Y	22.1
43	D	644.3121	-75.6	Y	66.1
44					
45	N	657.25	-69.4	3	
46	D	662.3329	-68.9	Y	45.1
47	N	669.26	-84.3	5	
48	D	674.3096	-52.1	Y	4.1
49	N	681.25	-66.7	4	
50	N	687.25	-40	1	
51	D	692.3327	-53.1	Y	50.1